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Impulse in Global Geomagnetic "Secular Variation", 1977–1979

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The global geomagnetic secular variation in the 1960's and 1970's was characterized by a rather rapid intensification which was shown to be of internal origin (Nevanlinna 1980). An external 11-year wave could also be identified (Nevanlinna, 1980; Yukutake and Cain 1979). In studying the global secular variation for the last few years, an even more rapid global change can be identified, namely a sudden enhancement followed by a deficit, lasting roughly two years from the end of 1977 to 1979. Here we shall demonstrate that the pulses of external origin and that it resembles an intensification of the magnetospheric ring-current system lasting for about two years.

The year to year change in the Z component in some European observatories is shown in Fig. 1. The enhancement in 1978 is clearly seen. The amplitude of ΔZ is largest at high latitudes, as can be seen from Fig. 2, which shows the corresponding amplitudes at all the observatories from which data were available at the appropriate time (Pushkov and Ivchenko 1979). The change in the H component is also shown in Fig. 2, its amplitude being largest at the equator. The first order harmonics, both external and internal, were calculated using the data shown in Fig. 2. The ΔZ and ΔH curves shown depict the calculated curves corresponding to the first order harmonics. The internal harmonic coefficient g^0_{1i} was found to be -0.5 nT/yr and the corresponding external one $g^0_{1e}=15$nT/yr, which shows, in spite of the large r.m.s. errors ($\sigma_Z=12$ nT/yr, $\sigma_H=3$ nT/yr, the dominant external character of the phenomenon. This, of course, can also be concluded from the negative sign of the H-variation corresponding to the positive change of Z at high northern latitudes.

By comparing monthly mean values of successive years from some Scandinavian observatories (Lovö, Nurmijärvi, and Sodankylä) we get the impression that the enhancement started as early as August 1977; it was clearly visible in November 1977, the maximum being in June 1978. From Fig. 1, where the point for 1981 is based on data for January to April only, we conclude that the phenomenon lasted throughout 1978 and 1979, but it does not seem to persist at the beginning of 1980, because the 1981–80 difference, calculated from the January to April data of these years, corresponds to the expected internal secular variation curce.

The curves in Fig. 2 depict ΔZ and ΔH in the geomagnetic dipole cordinate system supposing a homogeneous external field corresponding to a distant equatorial ring-current. The fit to ΔZ at high latitudes is not good. If the equatorial ring-current is brought to the normal ring-current distance of 4.5 Earth radii (L=3.5) and the ring-current is given a latitudinal extent up to 50° N and 50° S along the field lines, the fit is slightly improved.

In summary, a sudden change seems to have affected the magnetosphere in late 1977. The duration of the effect was some two years, which is longer than sudden changes are generally

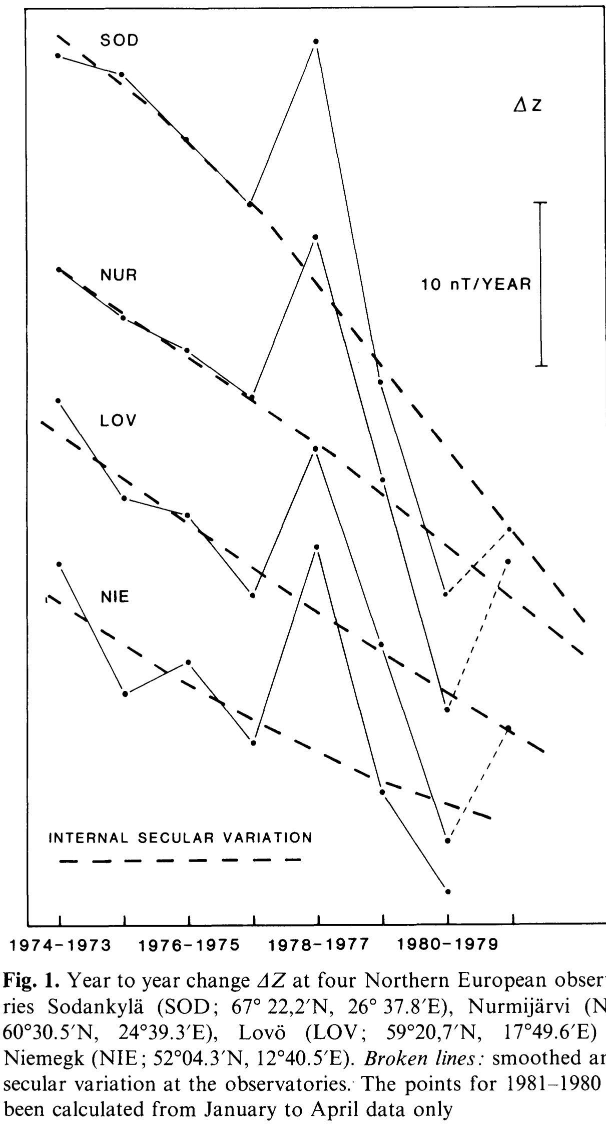

Fig. 1. Year to year change ΔZ at four Northern European observatories Sodankylä (SOD; 67° 22,2′N, 26° 37.8′E), Nurmijärvi (NUR; 60°30.5′N, 24°39.3′E), Lovö (LOV; 59°20,7′N, 17°49.6′E) and Niemegk (NIE; 52°04.3′N, 12°40.5′E). *Broken lines:* smoothed annual secular variation at the observatories. The points for 1981–1980 have been calculated from January to April data only

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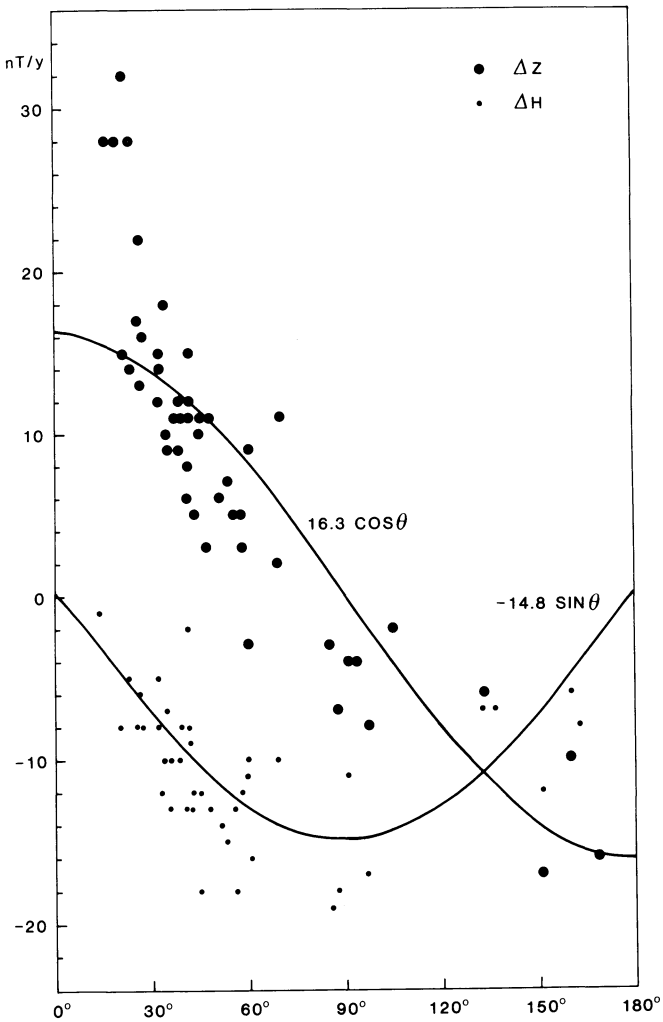

Fig. 2. *Large circles:* amplitude of enhancement in the secular variation of Z ($\Delta Z = (g^0_{1e} - 2g^0_{1i}) \cos\theta$) at different observatories. *Small circles:* corresponding H values ($\Delta H = -(g^0_{1e} + g^0_{1i}) \sin\theta$). θ is the dipole colatitude. The amplitude of the secular variation pulse was calculated by subtracting the smoothed extrapolated annual change 1979 – 1978 from the observed annual change 1978 – 1977. The smoothing was done by extrapolating the observed annual changes from 1974 – 1973, 1975 – 1974, 1976 – 1975, 1977 – 1976 to 1979 – 1978 linearly (see Fig. 1) The *curves* represent a least-squares fit of all points, the source being assumed to be a homogeneous axial field

expected to last. Looking back in time, we have not been able to find a similar effect before, perhaps because the absolute measurements, especially in Z, have not previously been accurate enough. The effect seems not to be correlated with magnetic activity indices. The effect behaves like an enhancement of the ring-current with a rather large N-S dimension. The simple ring-current model does not, however, explain the very large amplitudes in ΔZ at the 50°–70° northern latitudes, and this phenomenon needs additional explanation.

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